ADELPHI UNIVERSITY
Semi-Annual Progress Report
National Aeronautics and Space Administration
Grant NsG-394 Supplement I

Introduction

Reported on below are the research results in projects partially supported under National Aeronautics and Space Administration Grant NsG-394 Supplement I. The results will be reported on by project title.

It is to be remembered, however, that the research undertaken by project has been supplemented by various other activities including the invitation and appearance of various seminar speakers, (a list of whom is presented in Appendix A), and the development of cooperating research groups, as outlined and explained in more detail in Adelphi's request for continued support submitted earlier in February, 1965, to the National Aeronautics and Space Administration. The recognition and development of common interests, we view to be a valuable result of the activities undertaken under this grant The cross-stimulation between workers in the same field and workers in different disciplines we believe will make possible more rapid advances than if strict project support procedures were used as the only criterion for support.

Reported below are the detailed results of projects undertaken:

Research Project Results

a) Collision Processes in Gases - Dr. Donald E. Cunningham

The investigation of coherent photon capture in optically pumped mercury vapor have continued. These investigations in natural mercury are now drawing to a close with the successful acquisition of base-line data on the polarization of reemitted radiation as a function of vapor pressure of mercury (or equivalently the number of atoms per cubic centimeter). The effects of relatively small changes in number of atoms per cm^3 in the polarization state of the emitted radiation are very marked In Figure I it is shown that the polarization goes from about 20% at $2(10^{13})$ atoms/cm^3 to approximately 80% at 10^{12} atoms/cm^3. Over the next decade of atoms/cm^3 (i.e. 10^{12} atoms/cm^3 to 10^{11} atoms/cm^3) the polarization remains essentially constant. We have also studied the polarization as a function of applied magnetic field (the Hanlé method) in order to determine the lifetime of the excited state at various pressures. It appears, as indicated in Figure 2 that the lifetime settles on the natural lifetime (approximately $1.2 (10^{-7})$ secs) at populations less than 10^{12} atoms/cm^3. At
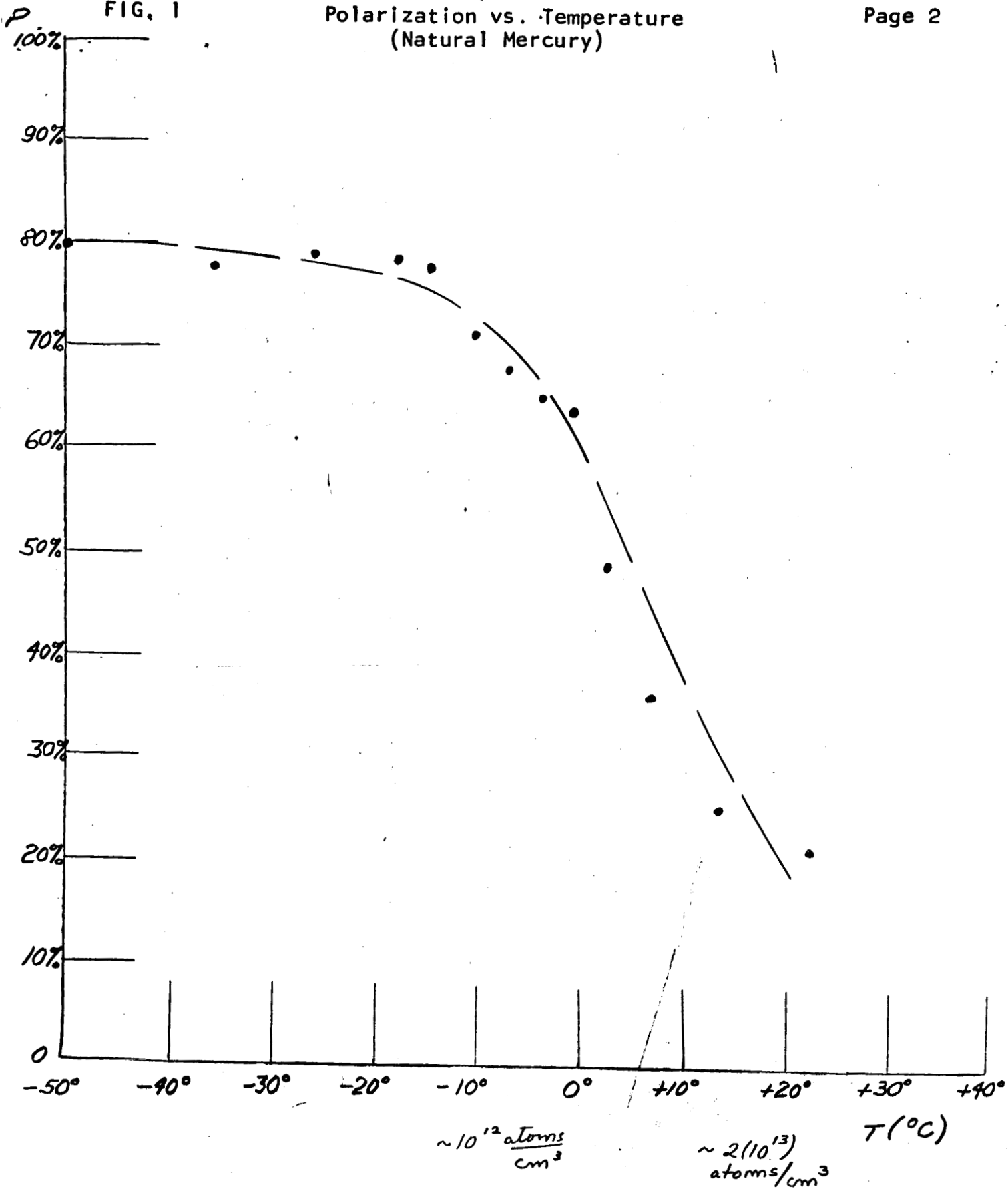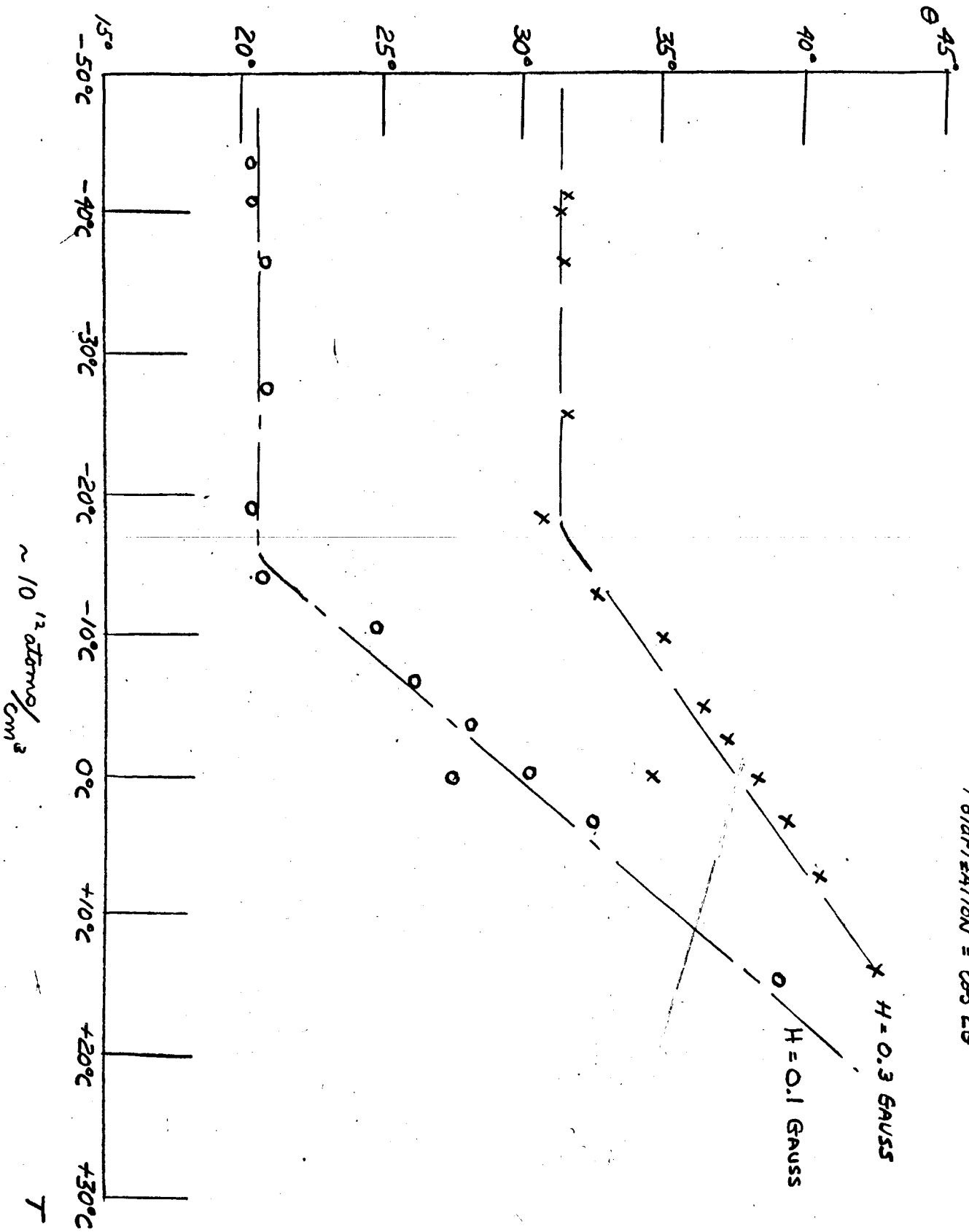
FIG. 1   Page 2

Polarization vs. Temperature
(Natural Mercury)

P

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0

-50° -40° -30° -20° -10° 0° +10° +20° +30° +40°

$\sim 10^{12} \dfrac{atoms}{cm^3}$

$\sim 2(10^{13}) \; atoms/cm^3$

$T(°C)$

FIG. 2

Observation Angle Θ , vs. Temperature T

for Constant H applied

Polarization = cos 2θ

higher population densities, there is a marked departure from the natural lifetime.

Studies are being planned with Hg^{198} and apparatus is being constructed to measure atomic collision cross sections using natural mercury as well as Hg^{198}. The procedure to be used is outlined in Reference 1, but basically involves observation of departures from the curves of Figure 1 and Figure 2 as a function of pressure of foreign gas (Argon, Neon, Krypton, etc.). The work undertaken above was carried on to supply valuable "base-line" data as well as to determine if, by using the phenomenon of "increased lifetime" due to the coherent photon capture process, we can investigate collisions at lower pressures of foreign gas (since the collision study technique is limited to collisions occurring in times comparable to the lifetime of the excited state, and hence to pressure of foreign gas). The "increased lifetime" might allow us to "tune" our apparatus to a given lower pressure of foreign gas and extend the pressure range of observations of collision cross sections.

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1. D. E. Cunningham and L. O. Olsen, Phys. Rev. 119, 691, 1960.

b) **Magnetic Susceptibility and Magnetothermal Oscillations in Beryllium** - Dr. Richard W. Genberg

   Variations in Magnetic Susceptibility

The detection system has been designed and described in a previous report[1]. Galvanometer system characteristics have been studied in detail. The galvanometer solar cell and light source have been ordered and are being combined into a working system. The amplifier, which will be sensing very weak signals from the solar cell, is to be a solid state differential amplifier. It will be very temperature sensitive, obviously requiring considerable care in its construction.

The magnetic field measuring device to be used is a Hall probe. The probe has been carefully calibrated (to an accuracy of $\pm 2\mu v$) and shows good reproducibility (to within two parts in 10^4).

Since mechanical noise places a limitation on the sensitivity of the torsion balance, the research dewar is being mounted to eliminate a large portion of that noise.

Sundry other items, e.g. vacuum bell jar and its base plate, the vacuum pumping system, etc., are being designed and either constructed or purchased.

(Assisting in the design and construction of the deHaas van Alphen apparatus is Eugene Hecht, a NASA predoctoral trainee and Ph.D. thesis student).

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1. NASA Proposal - NsG-394 Supplement 1

Magnetothermal Oscillations

The measuring apparatus for the magnetothermal oscillations will utilize a detector with a rapidly-varying temperature coefficient of resistance at the operating temperature. Several possibilities immediately suggest themselves and these are being investigated and evaluated. These include:

1. Semiconductor devices which demonstrate rapidly increasing resistance in the temperature range from $4^{\circ}K$ to $1^{\circ}K$, (e.g. carbon and germanium).

2. Manganin and constantan wire; although these exhibit abnormally low temperature coefficient of resistivity at room temperature, they do decrease quite rapidly with temperature at low temperatures and hence may serve as a good temperature detector in that range. Although these two may eventually be ruled out because of their anomalous behavior in a magnetic field, further investigation is necessary.

3. Superconducting alloys; these demonstrate rapidly decreasing resistance near the transition temperature. Au with 0.02% Fe or Ag with 1% Mn show desirable characteristics; others are also being considered. (Pure elements are ruled out because the transition is too "sharp"). Further investigation here is also required in order to ascertain the effects of a magnetic field on these alloys.

The work in the project will concentrate on the evaluation of the several systems discussed above and the subsequent fabrication of a working system to measure oscillations in beryllium. A discussion of the theory of the effects has been presented in a previous report as have the implications of the measurements to be taken.

c) Reactions with 3 Buten-1-ol and Phenethyl Alcohol with Lead Tetraacetate - Dr. S. Moon

The study of reaction mechanics and their role in chemical bonding has continued. In particular, studies have centered on obtaining an understanding of strength of chemical bonds, the breaking of bonds, and the formation of new bonds due to the obvious importance of these processes in the study of materials and material formation.

The research and results so far undertaken is summarized in the attached publication from the Journal of Organic Chemistry 29, 3453, 1964.

Since that time, primary efforts have centered on solvolysis of a derivative of 2-($\triangle$-cyclohexenyl) in order to investigate the sketetal rearrangement of this derivative as compared to results obtained in systems containing similar structures. These investigations are continuing.

d) <u>Effects of Varying Physical Parameters on Post Irradiated
Bacterial Cells</u> - Dr. Concetta B. Cabral

In the background of the major aspects of the problem has been
the continuation of a long series of techniques capable of the
isolation and identification of ancestral and aberrant forms
of the test organism being investigated; this has been accomplished
in conjunction with the adoption of basic staining and cultural
techniques tested and proven to be advantageous in the growth
and in the examination of the test organism.

Optimal procedures regarding each of the following aspects per-
taining to the problem have now been determined:

(1) most efficient quantitative determinations for the nutrient
broth cultivation of the test organism; (2) most efficient
quantitive estimations of bacterial growth exposed to diverse
environmental conditions; (3) maximum efficiency of our U-V
unit in modifying survival and mutational statistics in terms of
U-V intensity and integrated intensity; (4) most productive
solid medium for auxotrophic and prototrophic strains of the
test organism; (5) the organization of a definitive series of
tests to be used routinely in the determination of cultural,
morphological, and physiological modifications of the test
organism pursuant to and following exposure to ultra-violet
radiation; (6) determinations of the optimal times in the
growth cycle of the test organism (as we have found between the
15th and 16th hour following incubation rather than after the
traditional 24 hour incubation period) when tests could be
performed most efficiently and productively; (7) improvement
in techniques relating to the isolation and examination of
"delayed mutants";(8) the devisement of methods essential in
ascertaining the <u>precise time</u> marking the termination of the
period of susceptibility of the test organism to post-irradiational
environmental influences as well as the experimental conditions
necessary to elucidate this fact; (9) the devisement of methods
to determine <u>most rapidly</u> and efficiently the distribution of
variants into (a) spontaneously-induced ones, (b) experimentally-
induced ones, and/or; (c) naturally-selected ones; (10) methods
for determining whether initial variants are irreversible.

Some of the specific procedural techniques tested and now adopted
are: (1) plating at high dilutions to determine survival rates
wherein typically 0.1 ml of culture is diluted to 1 to 10^{-6};
(2) plating at lower dilutions to determine mutational rates;
(3) substitution of dilution fluid (25 ml. of nutrient broth
added to one liter of 0.9 Nacl) in place of saline un-enriched
by nutrient broth, the former allowing for maximal recovery
of cells; (4) cultivation of the test organism (prototroph)
in minimal medium designated as 50 X E, which is a salt solution
containing principally citric acid, potassium phosphate,
magnesium sulfate, and sodium ammonium phosphate added in
precise quantities.

Work is continuing in the above areas in the general problems of selection and control techniques as well as investigations to determine:

 1. The effects of varying temperature ranges and hydrogen ion concentrations on thiamine-, histidine-, and methionine- requiring strains of <u>Escherichia coli</u> following their exposure to ultraviolet light.

 2. To study the influence of the above-named environmental factors upon populational survival curves as well as upon mutation frequencies in post-irradiated bacterial cells.

e) <u>Study of Interrelationships Between the Physical, Chemical, and Biological Components of Disturbed Estuarine Systems</u> - Dr. Harry Brenowitz and Dr. Ronald Wilson

The 1964 data clearly indicates lower productivity in the disturbed system, when compared with the 1963 data (see line graphs). This is probably due to the fact that salinities have increased considerably so that conditions are not optimum for the dominant producer organisms. This further indicates that the bay is a disturbed ecological system. Theoretically, a complex mature ecosystem would have in reserve species which would grow under a wide variety of ecological conditions. The inherent instability of a system dependent on a single producer species is demonstrated by the data accumulated in these studies.

The application of these tentative conclusions to isolated life support systems should be considered. For if there are any deviations from the planned environmental conditions in an isolated system, the producer organism may be adversely affected thereby possibly destroying the entire system. It would seem advisable to have a reserve of several different producer organisms adapted for varied environmental conditions. We are presently investigating more complex systems and experimentally adjusting environmental conditions to determine their effect on productivity.

In addition to the projects reported on above, two other areas of research have been supported in part. These projects are in their early stages and as such are not as far advanced as those detailed above. A more detailed description is given below:

a) <u>Studies of Metal Solutions</u> - Dr. Stanley Windwer

The cyclic tetramer of propylene oxide was prepared twice by polymerisation with boron trifluoride-ether complex. The tetramer was separated from low and high boiling fractions using fractionating column filled with glass helixes. The fractions at 94°-122°C were collected at 5 mm mercury.
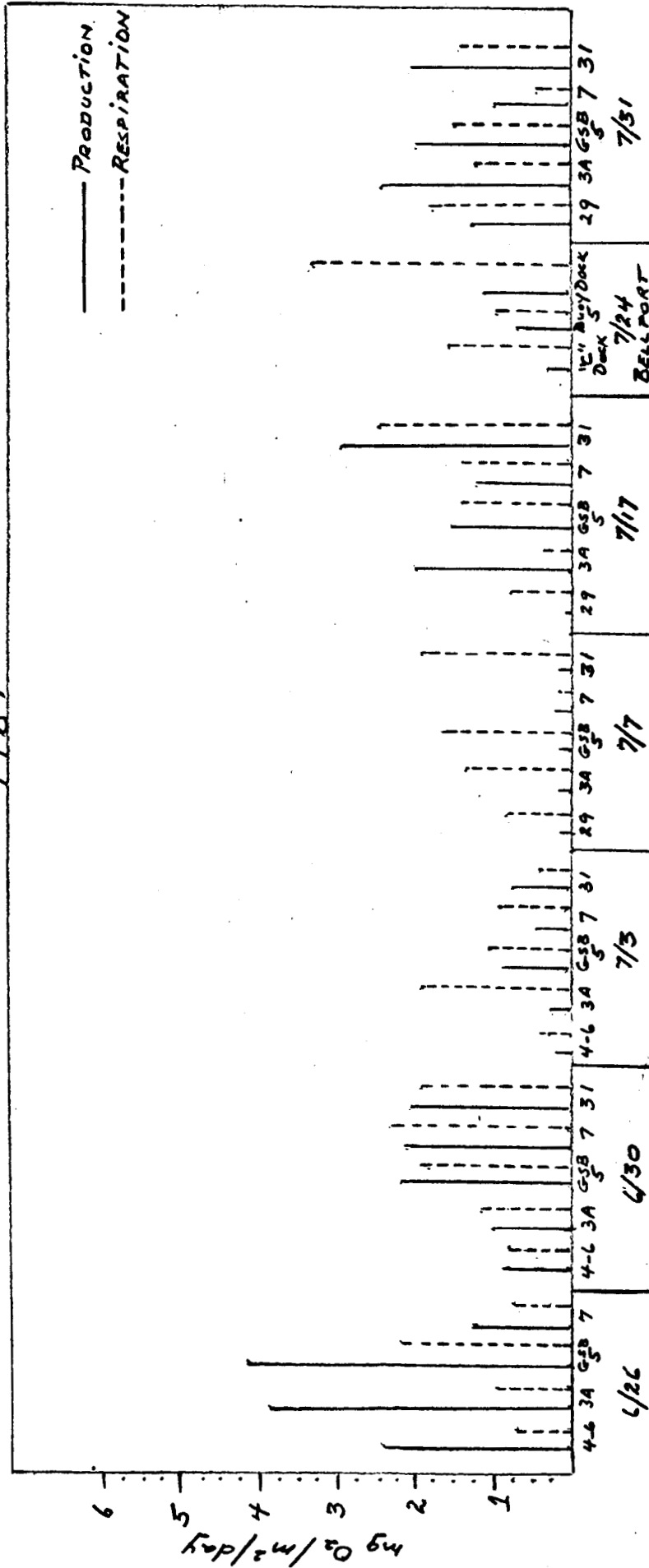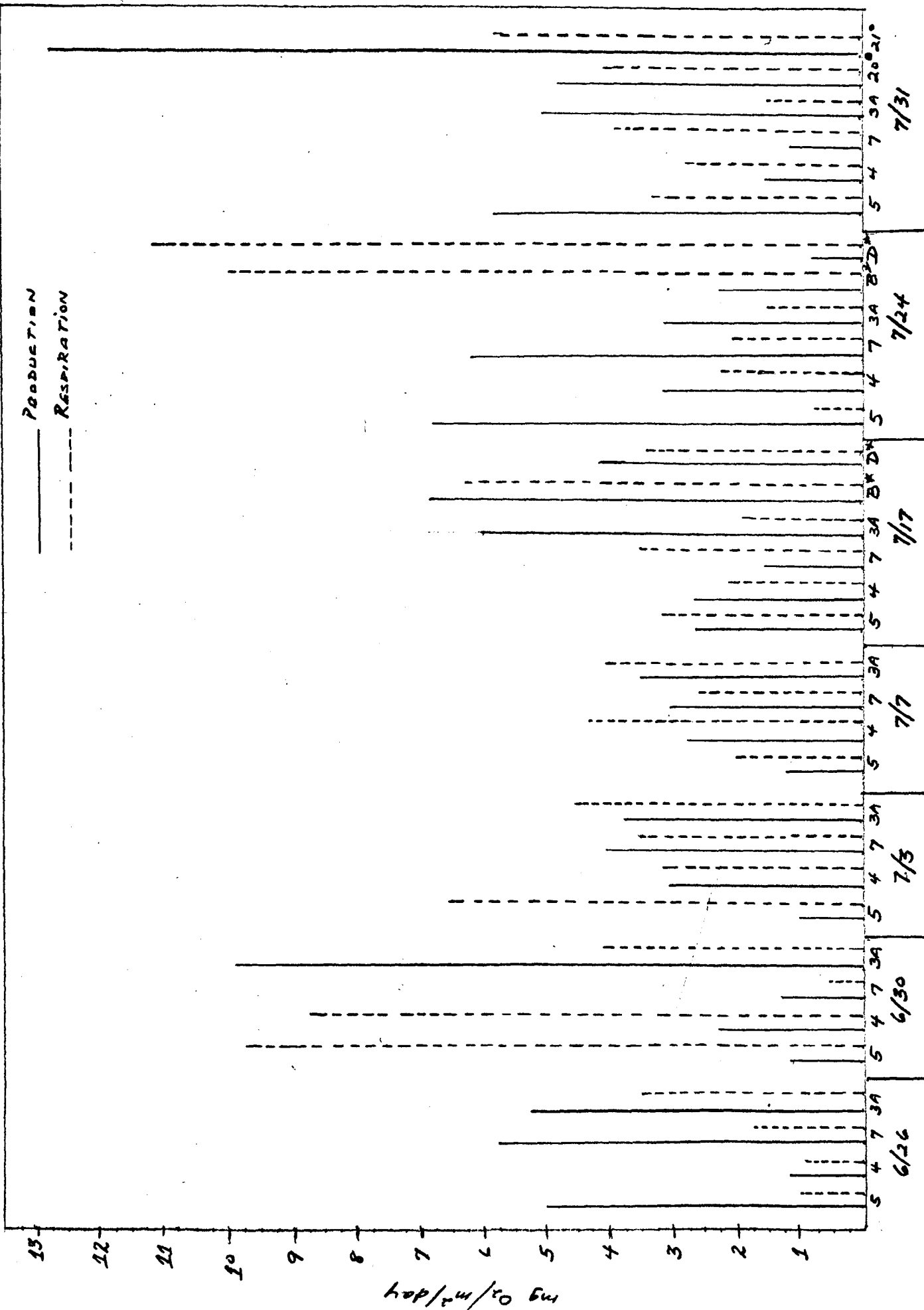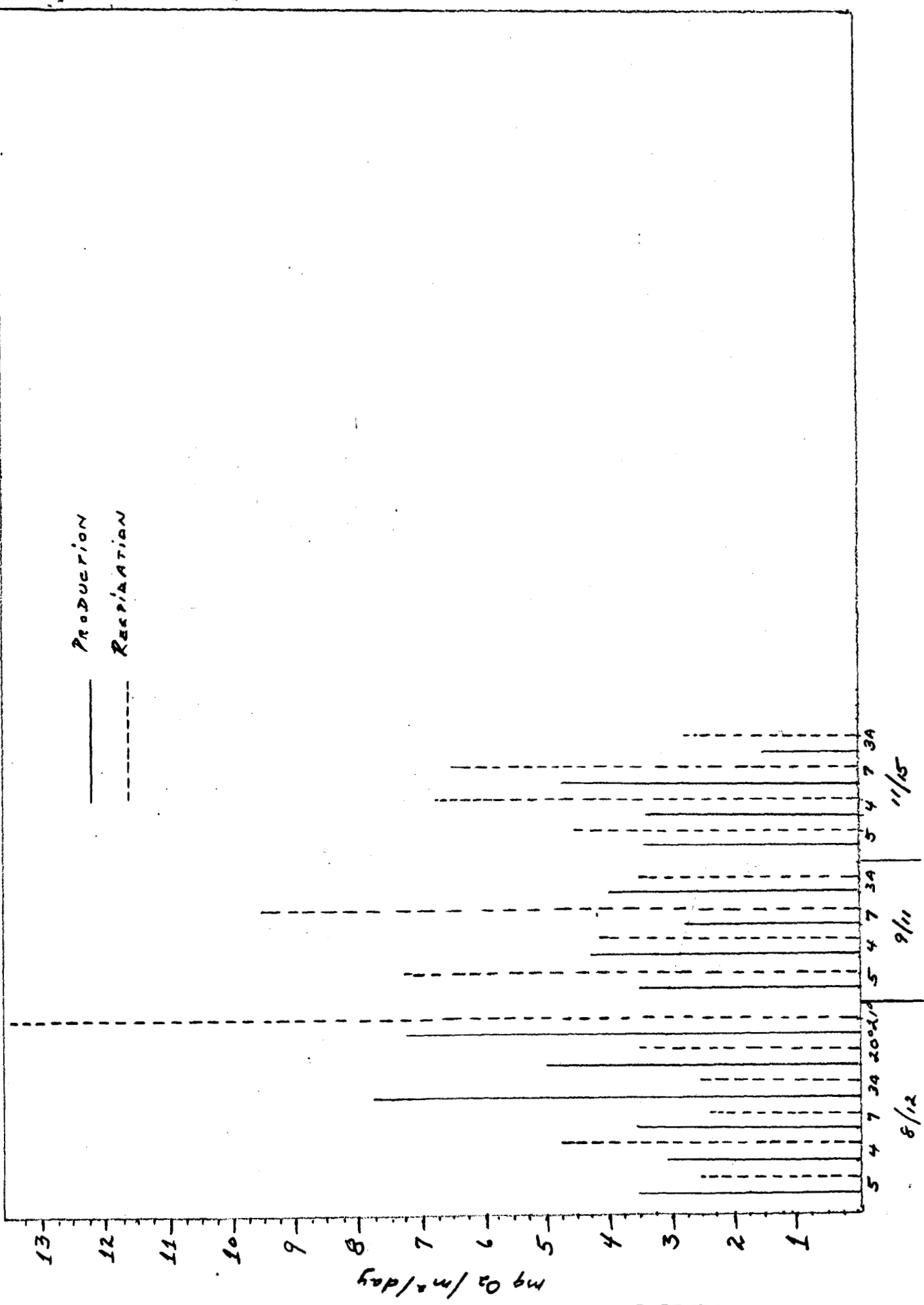
Line Graph 1 - Production - Respiration 1964.

LINE GRAPH 2a PRODUCTION-RESPIRATION 1963

BELLPORT
° COPAIGUE

Production
Respiration

Line Graph 2b - Production - Respiration 1963

Physical properties such as refractive index, density, and viscosity of this fraction were taken. A sample of the tetramer was sent out for analysis and it was found that the tetramer is about 97% pure.

The tetramer was than redistilled on the spinning band into two fractions at 5 mm mercury; fraction 1 $94^{o}-104^{o}C$ and fraction 2 $104^{o}-106^{o}C$. Sodium ribbon was added to these fractions to eliminate any water formed by air oxidation.

b) <u>Biochemical Studies of Polysacharrides</u> - Dr. John Kiyasu

The studies undertaken involve conversion of a naturally occurring polysacharride (glycogen) into a hydrophilic derivative (polyphosphate) or a hydrophobic derivative (polyacetate). Glycogen polyphosphate has been successfully synthesized and isolated. Its solvolytic properties on hydrophobic polymers are being investigated.

Further, as has been noted in Adelphi University's proposal for continuation of Grant NsG-394, there has occurred a consolidation of aims and hence projects to be undertaken by us in the future. In our current proposal, request for support has been made for neither of the two projects described above. Both have, however, received a successful start as a result of the "seed" funds made possible through this year's grant.

APPENDIX A

Seminar Speakers

Dr. Harold A. Scherage	Cornell Univ.	Recent Development on the Determination of Protein Conformation
Dr. Joseph Bunnett	Brown Univ.	The Mechanism of Aromatic Nucleophilic Substitution Involving Amine Nucleophiles
Dr. Konrad Bloch (Nobel Laureate)	Harvard Univ.	Multiple Enzymatic Patheays to Olefinic Acids
Dr. Torvard Laurent	Upsala Coll.	Theoretical Model for Gel Filtration
Dr. E. A. Mason	Univ. of Md.	Molecular Beams (2 lectures)
Dr. Andrew Streitwieser	Univ.of Calif.	Molecular Orbital Theory in Organic Chemistry, and The Acidity of Hydro-carbons
Dr. Antonio Carrelli	Univ. of Naples Italy	Measurements of Liquid Viscosity
Dr. D. Thurber	Lamont Geol. Lab.	Radiometric Dating of the Pleistocene and Recent
Dr. Kastler	Univ. of Paris	Optical Pumping

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Dr. Montroll	Institute for Defense Analysis	
Dr. Frederick Basolo	Northwestern Univ.	
Dr. Herbert Brown	Purdue Univ.	The Organaboranes in Synthetic Chemistry
Dr. W. Stockmeyer	Darthmouth Coll.	Dielectric Dispersion of Polymers
Dr. A. Maurice Taylor	Univ. of Southhampton	